IntesisBox®

MH-RC-MBS-1 v.0.6

MODBUS RTU (RS-485) Interface for MITSUBISHI HEAVY INDUSTRIES air conditioners.

User's Manual

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Order Code: **MH-RC-MBS-1**

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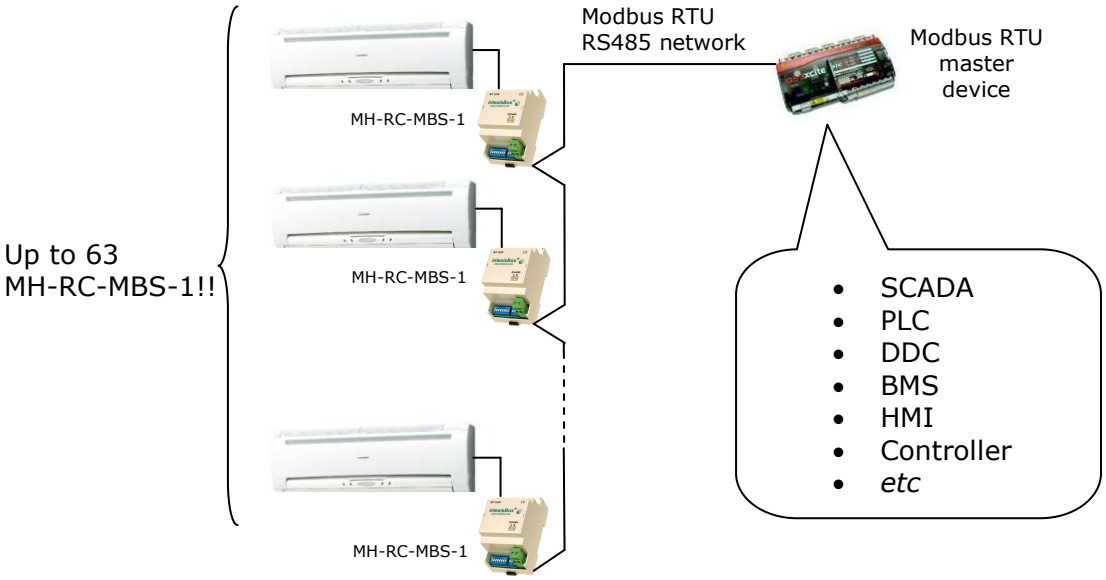
1. Presentation

The MH-RC-MBS-1 interface allows a complete and natural integration of ***MITSUBISHI HEAVY INDUSTRIES*** air conditioners into Modbus RTU (RS-485) networks.

Compatible with optional part SC-BIKN-E (more information in section 5).

- Reduced dimensions. 93 x 53 x 58 mm.
- Quick and easy installation.
  Mountable on DIN rail, wall, or even inside the indoor unit in some models of AC.
- External power not required.
- Direct connection to MODBUS RTU (RS-485) networks. Up to 63 MH-RC-MBS-1 devices can be connected in the same network.
  MH-RC-MBS-1 is a Modbus slave device.
- Direct connection to the AC indoor units. Up to 16 AC indoor units can be connected to MH-RC-MBS-1, controlling them as one (not individually).
- Configuration from both on-board DIP-switches and MODBUS RTU.
- Total Control and Supervision.
- Real states of the AC unit's internal variables.
- Allows using simultaneously the IR and wired remote controls and MODBUS RTU.



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2. Connection

2.1 Connection of the interface to the AC indoor unit

The MH-RC-MBS-1 connects directly to the MITSUBISHI HEAVY INDUSTRIES two wire X/Y bus. Depending on which controllers are available the recommended connection methods are the following (details in Figure 2.1):

- **Wired remote control available**. Connect the gateway as Slave in parallel with the wired remote controllers (Wall controller acts as master).
- **Infrared remote control available**. Connect the gateway as Master in parallel with the infrared remote controller (Infrared receiver) as Slave.
- **No remote control available** Connect the gateway directly to the X/Y bus of the indoor unit as Master when there is no MITSUBISHI HEAVY INDUSTRIES remote controller.

Disconnect mains power from the AC unit and use a 2 wire cable with a diameter of $2mm^2$ for the connection of MH-RC-MBS-1, MITSUBISHI HEAVY INDUSTRIES remote controller and its corresponding indoor unit. Screw the suitably peeled cable ends in the corresponding X/Y terminals of each device, as summarized in Figure 2.1.

Maximum X/Y bus length is 600 meters, cable has no polarity.

2.2 Connection of the interface to Modbus

Use the EIA485 connector in the MH-RC-MBS-1 to connect to the Modbus network.

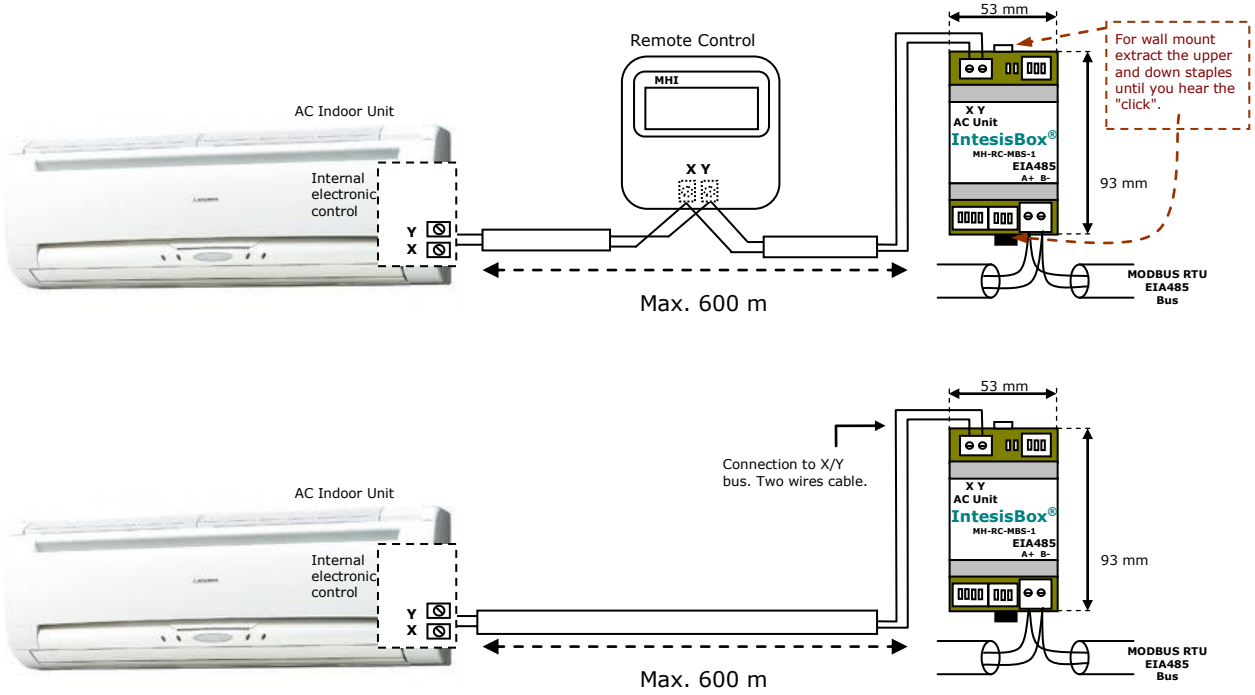

Figure 2.1 MH-RC-MBS-1 Connection diagrams

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2.3 Power-up

After the MH-RC-MBS-1 is properly connected, AC unit's main power can be connected again.

Then it will start an initialization process which can take around 2 minutes before the normal operation starts.

During this process, the master of the X/Y bus will show an indication of the initialization. In case that the MH-RC-MBS-1 is configured as master, the modbus register "error code" will be set to 65532 (see section 6). This error will be reset once the initialization is finished.

While the initialization is ongoing, some modbus registers will indicate an undetermined value (see section 3.2). Once the normal operation starts, they will acquire its corresponding value.

It is important to bear in mind that changes made during the initialization process will not have effect until it finishes.

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3. Modbus Interface Specification

3.1 Modbus physical layer

MH-RC-MBS-1 implements a MODBUS RTU (slave) interface, to be connected to an RS-485 line. It performs an 8N2 communication (8 data bits, no parity and 2 stop bits) with several available baudrates (2400 bps, 4800 bps, 9600 bps -default- and 19200 bps).

3.2 Modbus Registers

All registers are of type "16-bit unsigned register", in standard ModBus' big endian notation. The registers are accessible as "Holding registers" or "Inputs registers".

3.2.1 Control and status registers

<table>
<tr><th>Register Addr (protocol address)</th><th>Register Addr (PLC address)</th><th>R/W</th><th>Description</th></tr>
<tr><td>0</td><td>1</td><td>R/W</td><td>AC unit On/Off
0: Off
1: On</td></tr>
<tr><td>1</td><td>2</td><td>R/W</td><td>AC unit Mode
0: Auto
1: Heat
2: Dry
3: Fan
4: Cool</td></tr>
<tr><td>2</td><td>3</td><td>R/W</td><td>AC unit Fan Speed[1]
<table>
<tr><td></td><td colspan="4">Num. of Fan Speeds</td></tr>
<tr><td>Val.</td><td>4 (default)</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>0</td><td colspan="4">Undetermined</td></tr>
<tr><td>1</td><td>Low</td><td>Low</td><td>Low</td><td>High</td></tr>
<tr><td>2</td><td>Mid</td><td>Mid</td><td>High</td><td>-</td></tr>
<tr><td>3</td><td>High</td><td>High</td><td>-</td><td>-</td></tr>
<tr><td>4</td><td>Powerful</td><td>-</td><td>-</td><td>-</td></tr>
</table></td></tr>
<tr><td>3</td><td>4</td><td>R/W</td><td>AC unit Vane Position[1]
0: Undetermined
1…4: Pos. 1 … Pos. 4
10: Swing</td></tr>
<tr><td>4</td><td>5</td><td>R/W</td><td>AC unit Temperature Setpoint[2]
16..30 (ºC) (0 = undetermined)
61..86 (ºF) (0 = undetermined)</td></tr>
<tr><td>5</td><td>6</td><td>R</td><td>AC unit Ambient Temperature[2]</td></tr>
<tr><td>6</td><td>7</td><td>R/W</td><td>Window Contact[3]
0: Closed
1: Open</td></tr>
<tr><td>7</td><td>8</td><td>R/W</td><td>Device Disablement[3,4]
0: MH-RC-MBS-1 enabled
1: MH-RC-MBS-1 disabled</td></tr>
</table>

[1] Configurable according to Table 3.1
[2] Magnitude for this register can be adjusted through DIP switch (Check Table 3.4)

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Register Addr (protocol address)	Register Addr (PLC address)	R/W	Description
8	9	R/W	Remote Controller Disablement[3,4] ▪ 0: Remote Controller enabled ▪ 1: Remote Controller disabled
9	10	R/W	AC unit Operation Time[4] ▪ 0..65535 (hours). Counts the time the AC unit is in "On" state.
10	11	R	AC unit Alarm Status ▪ 0: No alarm condition ▪ 1: Alarm condition
11	12	R	Error Code Information in section 6
22	23	R/W	External sensor temperature[3] Can be ºC or ºF, x1 or x10 0x8000 (32768d) means "no input sensor"
43	44	W	Filter reset ▪ 1: Filter reset
44	45	R	Filter status ▪ 0: OK ▪ 1: Filter cleaning
45	46	W	Error reset ▪ 1: Error reset
46	47	R	Center/Remote[3] ▪ 0: Remote unlock (Center/Remote) ▪ 1: Remote lock (Center) ▪ 2: Remote (Remote)

3.2.2 Configuration Registers

Register Addr (protocol address)	Register Addr (PLC address)	R/W	Description
13	14	R/W	"Open Window" switch-off timeout[4,5] ▪ 0..30 (minutes) ▪ Factory setting: 30 (minutes)
14	15	R	Modbus RTU baudrate (bps)[6] ▪ 2400 ▪ 4800 ▪ 9600 ▪ 19200
15	16	R	Device's Modbus slave address[6] ▪ 1..63
21	22	R	Max number of fan speeds[1] ▪ 1..4: must be configured according to the number of fan speeds supported by the AC unit
49	50	R	Device Identification MH-RC-MBS-1: 0x0F00
50	51	R	Software version

[3] See explanation of this functionality in section 3.5
[4] This value is stored in non-volatile memory
[5] Once window contact is open, a count-down to switch off the AC Unit will start from this configured value
[6] Configurable through S3 (See Table 3.3 and Table 3.2)

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3.3 DIP-switch Configuration Interface

In this section the values of the configuration switches and their meaning are specified:

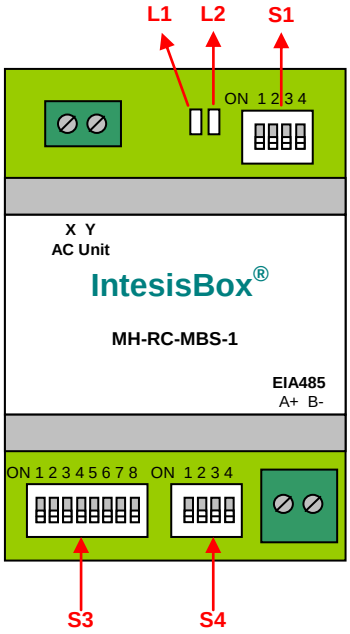

Figure 3.1 MH-RC-MBS-1

S1 – AC unit configuration: Master/Slave, Fan Speeds and Vanes

Binary value $b_3...b_0$	Decimal value	Switches 1 2 3 4	Description
0xxx	0	↓ x x x	Slave (default value) – A MITSUBISHI HEAVY INDUSTRIES Controller must be present in X/Y, configured as Master.
1xxx	1	↑ x x x	Master in X/Y bus – MITSUBISHI HEAVY INDUSTRIES Controller not needed in X/Y. If existing, it must be configured as Slave.
x00x	0	x ↓ ↓ x	Indoor unit has 1 Fan Speeds
x01x	1	x ↓ ↑ x	Indoor unit has 2 Fan Speeds
x10x	2	x ↑ ↓ x	Indoor unit has 3 Fan Speeds
x11x	3	x ↑ ↑ x	Indoor unit has 4 Fan Speeds (default value)[7]
xxx0	0	x x x ↓	Indoor unit has no Vanes
xxx1	1	x x x ↑	Indoor unit has Vanes (default value)

Table 3.1 S1 Switch configuration

[7] Fan speed DIP-switch must be configured according to the number of fan speeds supported by the AC unit

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S3 – Modbus protocol: Slave address and baudrate

Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8	Add	Switches 1 2 3 4 5 6 7 8
0	↓ ↓ ↓ ↓ ↓ ↓ x x	16	↓ ↓ ↓ ↓ ↑ ↓ x x	32	↓ ↓ ↓ ↓ ↓ ↑ x x	48	↓ ↓ ↓ ↓ ↑ ↑ x x
1*	↑ ↓ ↓ ↓ ↓ ↓ x x	17	↑ ↓ ↓ ↓ ↑ ↓ x x	33	↑ ↓ ↓ ↓ ↓ ↑ x x	49	↑ ↓ ↓ ↓ ↑ ↑ x x
2	↓ ↑ ↓ ↓ ↓ ↓ x x	18	↓ ↑ ↓ ↓ ↑ ↓ x x	34	↓ ↑ ↓ ↓ ↓ ↑ x x	50	↓ ↑ ↓ ↓ ↑ ↑ x x
3	↑ ↑ ↓ ↓ ↓ ↓ x x	19	↑ ↑ ↓ ↓ ↑ ↓ x x	35	↑ ↑ ↓ ↓ ↓ ↑ x x	51	↑ ↑ ↓ ↓ ↑ ↑ x x
4	↓ ↓ ↑ ↓ ↓ ↓ x x	20	↓ ↓ ↑ ↓ ↑ ↓ x x	36	↓ ↓ ↑ ↓ ↓ ↑ x x	52	↓ ↓ ↑ ↓ ↑ ↑ x x
5	↑ ↓ ↑ ↓ ↓ ↓ x x	21	↑ ↓ ↑ ↓ ↑ ↓ x x	37	↑ ↓ ↑ ↓ ↓ ↑ x x	53	↑ ↓ ↑ ↓ ↑ ↑ x x
6	↓ ↑ ↑ ↓ ↓ ↓ x x	22	↓ ↑ ↑ ↓ ↑ ↓ x x	38	↓ ↑ ↑ ↓ ↓ ↑ x x	54	↓ ↑ ↑ ↓ ↑ ↑ x x
7	↑ ↑ ↑ ↓ ↓ ↓ x x	23	↑ ↑ ↑ ↓ ↑ ↓ x x	39	↑ ↑ ↑ ↓ ↓ ↑ x x	55	↑ ↑ ↑ ↓ ↑ ↑ x x
8	↓ ↓ ↓ ↑ ↓ ↓ x x	24	↓ ↓ ↓ ↑ ↑ ↓ x x	40	↓ ↓ ↓ ↑ ↓ ↑ x x	56	↓ ↓ ↓ ↑ ↑ ↑ x x
9	↑ ↓ ↓ ↑ ↓ ↓ x x	25	↑ ↓ ↓ ↑ ↑ ↓ x x	41	↑ ↓ ↓ ↑ ↓ ↑ x x	57	↑ ↓ ↓ ↑ ↑ ↑ x x
10	↓ ↑ ↓ ↑ ↓ ↓ x x	26	↓ ↑ ↓ ↑ ↑ ↓ x x	42	↓ ↑ ↓ ↑ ↓ ↑ x x	58	↓ ↑ ↓ ↑ ↑ ↑ x x
11	↑ ↑ ↓ ↑ ↓ ↓ x x	27	↑ ↑ ↓ ↑ ↑ ↓ x x	43	↑ ↑ ↓ ↑ ↓ ↑ x x	59	↑ ↑ ↓ ↑ ↑ ↑ x x
12	↓ ↓ ↑ ↑ ↓ ↓ x x	28	↓ ↓ ↑ ↑ ↑ ↓ x x	44	↓ ↓ ↑ ↑ ↓ ↑ x x	60	↓ ↓ ↑ ↑ ↑ ↑ x x
13	↑ ↓ ↑ ↑ ↓ ↓ x x	29	↑ ↓ ↑ ↑ ↑ ↓ x x	45	↑ ↓ ↑ ↑ ↓ ↑ x x	61	↑ ↓ ↑ ↑ ↑ ↑ x x
14	↓ ↑ ↑ ↑ ↓ ↓ x x	30	↓ ↑ ↑ ↑ ↑ ↓ x x	46	↓ ↑ ↑ ↑ ↓ ↑ x x	62	↓ ↑ ↑ ↑ ↑ ↑ x x
15	↑ ↑ ↑ ↑ ↓ ↓ x x	31	↑ ↑ ↑ ↑ ↑ ↓ x x	47	↑ ↑ ↑ ↑ ↓ ↑ x x	63	↑ ↑ ↑ ↑ ↑ ↑ x x

Table 3.2 S3 Modbus Slave address

Binary value $b_0...b_7$	Decimal value	Switches 1 2 3 4 5 6 7 8	Description
xxxxxx00	0	x x x x x x ↓ ↓	2400bps
xxxxxx10	1	x x x x x x ↑ ↓	4800bps
xxxxxx01	2	x x x x x x ↓ ↑	9600bps (- default value)
xxxxxx11	3	x x x x x x ↑ ↑	19200bps

Table 3.3 S3 Modbus baudrate

S4 – Temperature and termination: Degrees/Decidegrees (x10), temperature magnitude (ºC/ºF) and EIA485 termination resistor

Binary value $b_0...b_3$	Decimal value	Switches 1 2 3 4	Description
0xxx	0	↓ x x x	Temperature values in Modbus register are represented in degrees (x1) (default value)
1xxx	1	↑ x x x	Temperature values in Modbus register are represented in decidegrees (x10)
x0xx	0	x ↓ x x	Temperature values in Modbus register are represented in Celsius degrees (default value)
x1xx	1	x ↑ x x	Temperature values in Modbus register are represented in Fahrenheit degrees
xxx0	0	x x x ↓	EIA485 bus without termination resistor (default value)
xxx1	1	x x x ↑	Internal termination resistor of 120Ω connected to EIA485 bus**

Table 3.4 S4 Temperature and termination configuration

* Default value
** Only in the interfaces connected at both ends of the bus must be activated the termination resistor, not in the rest. The EIA485 bus can be biased through internal jumpers JP1. See section 3.7.

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3.4 Implemented Functions

MH-RC-MBS-1 implements the following standard MODBUS functions:

- 3: Read Holding Registers
- 4: Read Input Registers
- 6: Write Single Register
- 16: Write Multiple Registers (Although this function is allowed, the interface does not allow write operations of more than 1 register with the same request, this means that length field should always be 1 when using this function for writes)

The maximum number of registers that can be read in a single request is 100.

3.5 Special behaviours

3.5.1 Window contact

The MH-RC-MBS-1 has the functionality of automatically control the turning off of the AC indoor unit depending on the state of the window contact register.

The AC indoor unit will be turned OFF and if the window contact register indicates "window opened" for a certain period of time (default value: 30 minutes).

If the AC unit is turned on through either the remote controller or the On/Off register and the window contact is still indicating "window opened", it will restart the countdown of the 30 minutes and after that it will turn OFF the AC unit again.

If the window contact register is indicating "window closed", this functionality will have no effect to the normal operation.

3.5.2 External temperature sensor. Virtual temperature

As master of the X/Y bus, the MH-RC-MBS-1 will always send the temperature of the external temperature sensor directly to the AC unit. This temperature will become the AC unit's temperature.

As slave of the X/Y bus, if there is an external temperature sensor, it will send a different set point temperature to the AC unit from the one entered by the user. Its calculation is described below.

Four temperatures are involved:

- Set point temperature: set point temperature sent to the AC unit (S)
- Return path temperature: ambient temperature sent by the AC unit (T_r)
- Virtual set point temperature: set point temperature requested by the user (setpoint register). (S_v)
- Virtual ambient temperature: ambient temperature measured by the external temperature sensor. (T_v)

The set point temperature sent to the AC indoor unit is calculated with the following formula:

$$S = S_v - (T_v - T_r)$$

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3.5.3 Device disablement

If the device disablement register is set to 1, it will not allow the MH-RC-MBS-1 to change the state of the AC unit. All the modbus registers will show the current state of the AC unit as if they were "Read Only registers".

3.5.4 Remote controller disablement

When the remote controller is disabled, changes made by the remote controller will be corrected by the MH-RC-MBS-1 setting the previous value. In this way, the MH-RC-MBS-1 will prevent the remote controller from changing the state of the AC unit.

3.5.5 Center/Remote

The Center/Remote register can be set to three different values:

- 0: **Remote unlock** (Center/Remote). The indoor unit is being controlled by a BMS and it can be managed from the BMS, the remote controller or the MH-RC-MBS-1.
- 1: **Remote lock** (Center). The indoor unit is being controlled by a BMS and it can only be managed by the BMS. In this situation the MH-RC-MBS-1 is disabled, like when the device disablement register is set to 1.
- 2: **Remote** (Remote). The indoor unit is **not** being controlled by any BMS. It can be managed from the remote controller or the MH-RC-MBS-1.

3.6 Device LED indicator

The device includes two LED indicators (check Figure 3.1) to signal its different possible operational states. Their meaning is explained in this section:

L1 (green)			
Operation	**ON**	**OFF**	**Meaning**
Blinking	500 ms	500 ms	Error
Flashing	100 ms	1900 ms	Normal operation (configured and working)

L2 (red)			
Operation	**ON**	**OFF**	**Meaning**
Pulse	3 sec	--	Undervoltage

L1 (green) & L2 (red)			
Operation	**ON**	**OFF**	**Meaning**
Pulse	5 sec	--	Device start-up
Alternate blinking	500 ms	500 ms	Flash checksum not OK

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3.7 RS485 bus. Termination resistors and Fail Safe Biasing mechanism

RS485 bus requires a 120Ω terminator resistor at each end of the bus to avoid signal reflections.

The MH-RC-MBS-1 device includes an on-board terminator resistor of 120Ω that can be connected to the RS485 bus by using DIP-switch (Table 3.4).

A fail safe biasing circuit has also been included in the board of MH-RC-MBS-1, it can be connected to the RS485 bus by placing the internal double jumper JP1 (see details in Figure 3.2). This fail safe biasing of the RS485 bus must only be supplied by one of the devices connected to the bus.

Some Modbus RTU RS485 master devices can provide also internal 120Ω terminator resistor and/or fail safe biasing (consult the technical documentation of the master device connected to the RS485 network in every case).

Location of jumper and DIP-switches for RS485 bus Termination resistor or Fail Safe Biasing selection:

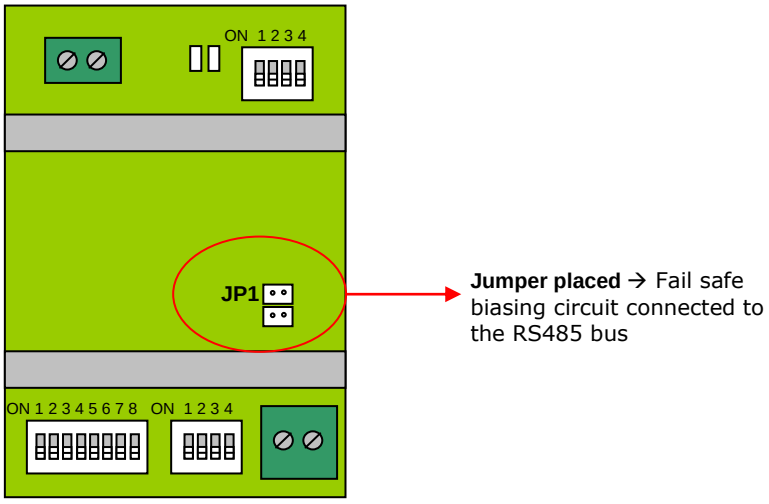

Figure 3.2 Fail Safe jumper

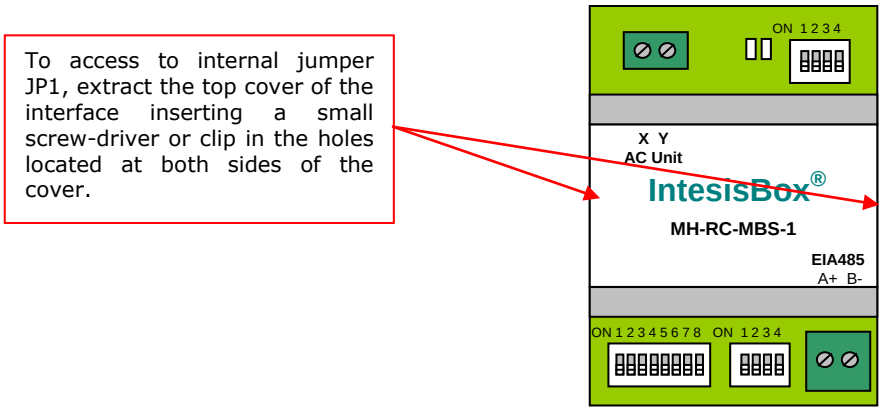
To access to internal jumper JP1, extract the top cover of the interface inserting a small screw-driver or clip in the holes located at both sides of the cover.
ON 1234
X Y
AC Unit
IntesisBox®
MH-RC-MBS-1
EIA485
A+ B-
ON 12345678 ON 1234

Figure 3.3 Accessing the jumper

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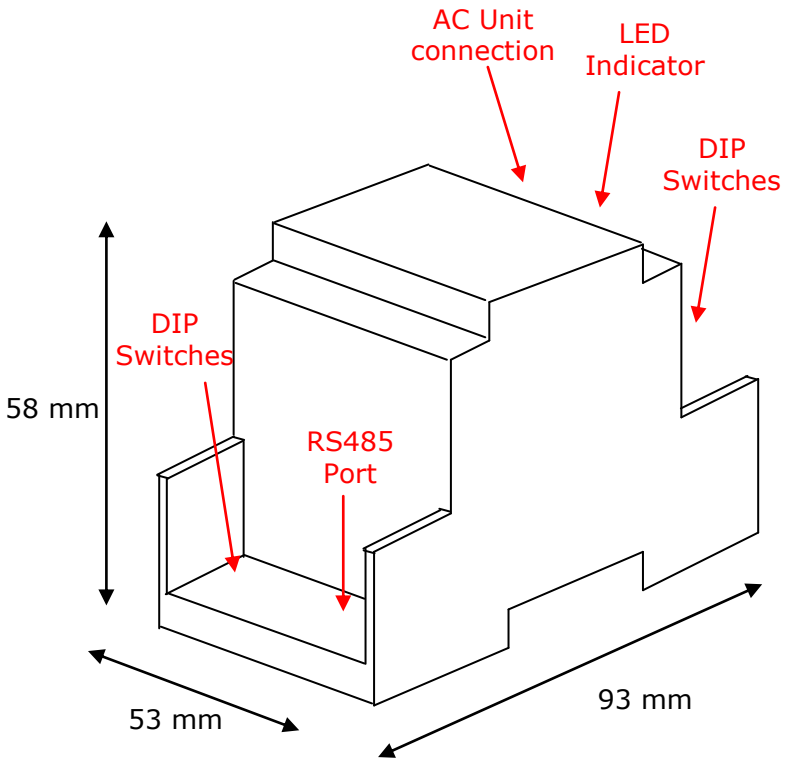
4. Specifications

Dimensions:	*93 x 53 x 58 mm*
Weight:	*85 g*
Consumption Current:	*80 mA*
Operating Temperature:	*-40 . . . 85ºC*
Stock Temperature:	*-40 . . . 85ºC*
Operating Humidity:	*<95% RH, non-condensing*
Stock Humidity:	*<95% RH, non-condensing*
Isolation voltage:	*1000 VDC*
Isolation resistance:	*1000 MΩ*
Modbus Media:	*Compatible with Modbus RTU - RS485 networks*



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5. AC Unit Types Compatibility

A list of Mitsubishi Heavy Industries indoor unit model references compatible with MH-RC-MBS-1 and their available features can be found in:

http://www.intesis.com/pdf/IntesisBox_MH-RC-xxx-1_AC_Compatibility.pdf

6. Error Codes

Error Code Modbus	Error in Remote Controller	Error Description
0	N/A	No active error
1	E1	Remote controller communication error
2	E2	Duplicated indoor unit address
3	E3	Outdoor unit signal line error
5	E5	Communication error during operation
6	E6	Indoor heat exchanger temperature thermistor anomaly
7	E7	Indoor return air temperature thermistor anomaly
8	E8	Heating overload operation
9	E9	Drain trouble
10	E10	Excessive number of indoor units (more than 17) by controlling one remote controller
12	E12	Address setting error by mixed setting method
14	E14	Communication error between master and slave indoor units
16	E16	Indoor fan motor anomaly
19	E19	Indoor unit operation check, drain motor check setting error
28	E28	Remote controller temperature thermistor anomaly
30	E30	Unmatched connection of indoor and outdoor unit
31	E31	Duplicated outdoor unit address No.
32	E32	Open L3 Phase on power supply at primary side
33	E33	Inverter primary current error
35	E35	Cooling overload operation
36	E36	Discharge pipe temperature error
37	E37	Outdoor heat exchanger temperature thermistor anomaly
38	E38	Outdoor/Ambient air temperature thermistor anomaly
39	E39	Discharge pipe temperature thermistor anomaly
40	E40	High pressure error
41	E41	Power transistor overheat
42	E42	Current cut
43	E43	Excessive number of indoor units connected, excessive total capacity of connection
45	E45	Communication error between inverter PCB and outdoor control PCB
46	E46	Mixed address setting methods coexistent in same network
47	E47	Inverter over-current error
48	E48	Outdoor DC fan motor anomaly
49	E49	Low pressure anomaly
51	E51	Inverter anomaly
53	E53	Suction pipe temperature thermistor anomaly
54	E54	High/Low pressure sensor anomaly
55	E55	Underneath temperature thermistor anomaly
56	E56	Power transistor temperature thermistor anomaly
57	E57	Insufficient in refrigerant amount or detection of service valve closure
58	E58	Anomalous compressor by loss of synchronism
59	E59	Compressor startup failure
60	E60	Rotor position detection failure / Anomalous compressor rotor lock
61	E61	Communication error between the master unit and slave units
63	E63	Emergency stop
65532	N/A	Initialization process. See section 2.3
65535	N/A	Communication error between MH-RC-MBS-1 and AC unit / Remote controller

In case you detect an error code not listed, contact your nearest MITSUBISHI HEAVY INDUSTRIES technical support service.

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